REMOTE SENSING UTILITY IN A DISASTER

STRUCK URBAN ENVIRONMENT

Annual Progress Report

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by

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A. STATEMENT OF GOALS AND OBJECTIVES

1. Remote Sensing and Public Health. The general purpose of this research is to explore and present ways that a new technology--remote sensing--can contribute to solutions of urban public health problems in time of natural disaster. The objectives of this project are to determine and describe remote sensing standard operating procedures for public health assistance during disaster relief operations which will aid the agencies and organizations involved in disaster intervention. We plan to test the validity of this technology by applying it in a post-disaster situation (if such a disaster occurs in our space and time frame) and comparing it, where possible, to existing methods of gathering information. The important variable here is time since existing methods do eventually accumulate necessary data. This research is analogous to a therapeutic trial in that we are testing one "vaccine"--remote sensing--against other "vaccines"--existing approaches.

2. Disasters and Public Health. Disasters interrupt systems necessary to maintain the public health. It is necessary not only to reestablish all the interrupted systems on which the protection of health of a community relies; but, to manage the potential and real public health problem during the period of reestablishment. The activities involved in doing this may seem from one perspective to have no relation to health, but from another perspective they are the underpinnings on which the health of a community depends. Two

points need to be made clear: (1) Public health activities are broad-spectrum, that is, they are carried out on a societal as well as on an individual level, and (2) the emphasis in public health is on prevention, not cure. Medical care per se or effective treatment of illness, it has been argued, "has little, if any, effect on the health of a community" (Stallones, 1972). In fact, for some diseases successful treatment may even increase the burden of illness in the community. From a community health perspective, medical care or treatment of illness "represents the failures of community health" (Stallones).

When we consider prevention in relation to natural disasters we do not mean to imply prevention of the event since with most types of natural disaster this is not yet possible. This research emphasizes a preventive approach to the effects of disasters and specifically to post-disaster problems that relate to public health concerns during the emergency phase of relief. It is generally agreed upon that there are three phases of relief activities following a disaster. The first is the emergency phase during which persons impacted by the disaster are rescued and first aid and other medical care are administered. This phase is followed by the recovery period during which time residents of the community assess their situation and work toward reestablishing a stable way of life. Public health concerns at this time may revolve around treatment of illness which might have occurred as either a result of the disaster, a result of actions taken during

the emergency phase, or other factors such as the prevalence of certain disease types pre-disaster. The final phase deals with restoration and rehabilitation of the community to pre-disaster conditions and may take from weeks to years depending on the type of disaster and economic resources available to the community.

Concerns of the emergency phase may range from reestablishing transportation routes into an area cut off by a disaster to the identification of environmental factors which foster disease occurrence. In a disaster context, medical care, while remedial, may also come under the umbrella of public health coordination activities. Public health in the context of disaster relief encompasses the total scope of community health, namely, all the community efforts influenced by the medical arts and sciences, applied to the prevention of disease, protection of life, and the promotion of the well being and efficiency of man, inclusive of the physical, mental, and social aspects.

3. End Product: Manual for disaster managers. Originally, two manuals or suggested operations guides were planned--one a technical guide for data gathering and analysis, and another describing potential applications of the data gathered. The first guide was to be directed to a remote sensing specialist. It was to outline the tasks to be performed by an image analyst including both preplanning and post-disaster activities. Plans for this guide were

dropped. After reviewing the first annual report, our grant monitors suggested (Appendix A) that the scope of the grant be limited to developing and testing a guide for disaster managers.

A guide was then written for agency personnel outlining by public health problem the functions and tasks involved in disaster relief. Evidence exists to show that inappropriate actions on the part of disaster relief managers have frequently contributed to unnecessary mortality, morbidity and inefficient use of resources (Center for Disease Control, 1974). Mismanagement problems are most often caused by a lack of knowledge and/or skill of the work functions required to manage disaster relief. Our guide enumerates tasks which can be accomplished or aided by remote sensing. This guide is unique in two respects: (1) It documents functions and tasks which are nowhere clearly outlined and so imparts knowledge to those who cannot rely on experience as well as specifying in diagramatic form these same tasks for experienced personnel, and (2) It suggests a systematic and novel application of an improved technology for solving a serious problem.

B. HYPOTHESES

We have formulated the following hypotheses:

1. Remote sensing technology can supply data faster, more completely, and more accurately than current methods.
2. Using this method of intervention, we can assist

reduction of management errors in a disaster caused by information delay.

Testing the difference in quality of data collected at comparable time intervals from current methods and from remote sensing would ideally require that the two collection systems were used simultaneously and then compared. This could be done if an actual disaster were to occur in the time frame of the current project. A second testing procedure would be to make a retrospective study of the time required for collection and its quality by interviewing persons recently involved in a disaster. This information could be compared to the estimate derived from a simulation whereby remote sensing is used to provide the same data.

Testing the second hypothesis is very difficult and will not be undertaken since it is virtually impossible to conduct a controlled exposure validation. This would entail having the same disaster strike two similar communities with equal intensity at the same time and exposing one to remote sensing while using the other as a control community without the use of remote sensing. Additionally, we have no mechanism whereby decision-makers would be limited to utilize data from remote sensing sources. However, we will demonstrate its usefulness by the guide which presents the problems in flow chart form to encourage such utilization.

C. SECOND YEAR STEPS

This section details the steps which have been taken

to complete the research described above.

1. Iterations of the guide. Following an extensive literature review and a number of interviews with knowledgeables in the field of disaster management (first year annual report), the staff drafted a manual. This guide was reviewed internally and was redrafted four times before being sent out for external review.

Our primary concerns in writing the manual were that it be written in an understandable manner, that the guide be kept general so as not to preclude individual adaptations, and that the applications we described were feasible and could be implemented with a reasonable amount of planning.

Preplanning for natural disasters is a subject which is much discussed and encouraged by EOC directors but which lacks implementation in most communities. This guide strongly emphasizes preplanning and includes charts and tables of recommended baseline data for the six public health problem areas. These tables can serve as guidelines for communities wishing to compile such data.

The main functions which need to be performed in a natural disaster to maintain or restore the public health were examined, and the ability to use remote sensing data to fulfill these functions was described. Technical information on remote sensing systems which would be adaptable to natural disasters will be written up as an appendix to the guide.

This process of writing and rewriting lasted approximately six months (January-June, 1975). A draft copy of the manual

forms Appendix B.

2. Review of Guide. A draft copy of the guide was mailed out to 35 disaster managers and consultants for their comments, and follow-up interviews were conducted by the staff. Where personal interviews were not possible due to distance or other factors, written feedback was solicited. Three months were spent interviewing disaster managers.

Response to the guide was for the most part favorable. The clarity and readability of the guide were affirmed as was the feasibility of the concept. The need for preplanning was asserted; a major obstacle to this end was identified in the lack of resources, i.e., limited personnel to assign the task of accumulating pre-disaster data.

Comments of reviewers pertaining to organization of the guide are currently being analyzed. A list of reviewers appears as Appendix C.

D. THIRD YEAR PLANS

The guide will be reorganized and rewritten in accordance with the suggestions for change made by reviewers. Comments from additional reviewers whose names were solicited from initial interviewees will be asked to critique the rewritten guide.

Some city EOC's have planned simulation exercises during 1976. The staff will attend one or more of these exercises as on-site observers to validate experientially the concepts and procedures in the manual. If possible, arrangements will be made to use the guide as part of the simulation exercise.

E. TRIPS AND MEETINGS, SECOND YEAR

1. Disaster Research Center, Ohio State University.

DATE: April 24, 1975

Drs. Russell Dynes and Quarantelli were interviewed in regard to their purposes and procedures in disaster research. They provide experience to persons interested in the sociological aspect of public service reactions to disaster situations. We gained from the visit a bibliography on related works, interview forms and general knowledge regarding disaster research.

2. Presentations.

Texas Gulf Coast Civil Defense Directors.

DATE: October 31, 1975

A summary of the concepts and procedures contained in the manual were presented to this group.

APPENDICES

LIST OF APPENDICES

APPENDIX A

Grant Monitor's Letter of 2/19/75

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: DE63/2-75/19

Marjorie Rush, Ph.D.
University of Texas School of Public Health
P. O. Box 20186
Houston, TX 77025

Dear Doctor Rush:

I acknowledge receipt of your annual report entitled, "Remote Sensing in a Disaster-Struck Urban Environment." I commend you on a fine report.

Recognizing the real concern for funding, time (grant termination 31 Aug 76), and capabilities, Mr. Vitale and I feel that rather than dilute your efforts, your greatest contribution toward the overall effort would be to have you dedicate your time toward producing one manual. This manual would address the user agencies, describing to them the potential applications of remote sensing data to disaster assessment and relief. The manual addressing the image analyst will be a subject for further funding. It is acknowledged that you will not analyze any realtime data from a natural disaster.

I would appreciate a briefing sometime in March or April at your convenience. Let me know if I can be of further assistance.

Sincerely,

F. T. Satalowich

APPENDIX B

Draft Copy of Guide

HELPING THE

DISASTER MANAGER

---DRAFT COPY---

By

M. Rush, A. Holguin, S. Vernon

U.T. SCHOOL OF PUBLIC HEALTH

Houston, Texas

August 15, 1975

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Chapter 1

MANAGEMENT OF DISASTER RELIEF: STATEMENT OF THE PROBLEM

Examples of the mismanagement of disaster relief abound. Probably the most typical situation is the inundation of a disaster area with unneeded resources (Rennie, 1970; Faich, 1973). One of the factors which probably contributes to this situation is the lack of accurate information in the early phases of a disaster on which to base an assessment of relief needs (League of Red Cross Societies, Steering Committee, 1975). Arranging for the distribution of relief goods within the disaster area once needs have been identified often is not planned (Rennie, 1970; Kroger, 1971; Faich, 1973, League of Red Cross Societies, Editorial, 1975). Thus, although not anticipated, it is frequently the case that attempts to alleviate the results of a disaster, contribute to already existing problems (U.S.D.H.E.W., 1974). The public health of a stricken community depends on the smooth functioning of relief activities and on the rapid restoration of service systems in the community.

Evidence shows that mismanagement problems are frequently caused by a lack of knowledge and/or skill of the work functions required to manage disaster relief (U.S.D.H.E.W., 1974). Disaster plans, where available, often fail to outline the relief functions and tasks sufficiently so that even experienced personnel do not have a clear overview of what needs to be accomplished. Since in a given community disasters strike infrequently, it is likely that people with some previous experience in disaster relief management will be scarce. Also the nature of disasters that affect communities is likely to change so previous experience may not be specifically applicable. Lack of knowledge is an even more acute problem for inexperienced personnel.

Most city and state Standard Operating Procedures (SOP's) for disaster management begin with the assumption that decisions about the type and quantity of the resources required to minimize the disaster impact have been made. These SOP's generally list the responsibilities of various agencies and describe how to implement tasks. For example, as stated in one city SOP, the Department of Public Health has responsibility for providing medical care and treatment for the ill and injured. This plan assumes that decisions about whether or not medical attention is actually needed, whether or not it can be handled locally, and whether or not facilities are adequate, have been made. We have not found evidence to support the belief that these decisions are made in a systematic way. In other words, disaster plans where they exist have been organized around decisions that have not been made explicit. Further, as mentioned, it appears that information on which to base decisions of this type is not easily available.

SOP's usually detail tasks by agencies rather than by functions to be accomplished. This approach appears to lead to fragmentation and duplication of effort since restoring certain systems following a disaster may cross-cut several agencies' duties. For example, checking and restoring the water system and supplying water may involve the Division of Engineering Services which is responsible for checking and repairing the system, the Health Department which is required to test for contamination, local government and/or distributes water to areas where the supply has been cut off, and the Department of Safety and Transportation for movement of water tanks. A more wholistic approach to disaster management is to diagram work functions without consideration of agency boundaries, and this is the approach of this manual. Disaster relief activities have been divided into

six general areas representing public health concerns: medical services, water, waste disposal, shelter, food, and transportation. Problem-solving contingencies were elaborated within a decision-making framework identifying what has to be done to "solve" a disaster problem.

This manual outlines the generic functions which officials need to perform or consider to manage relief more efficiently. It includes a description of:

1. WHAT functions must be performed to adeuately manage a disaster;

2. WHEN (in what sequence, under what conditions) each function should be performed (U.S.D.G.E.W., 1974);

3. WHAT baseline information would facilitate decision-making; and

4. HOW remote sensing information -- a data source not systematically used -- may be of benefit in decision-making about disasters and may be incorporated into existing disaster plans.

We are assuming that disaster managers will know how to perform the functions described, who has the responsibility for performing each function, what additional resources might be needed, how to obtain these resources, and how to determine when each function has been performed. Information "bits" necessary to consider delivery of disaster relief were identified by defining these specific functions and tasks. It was then possible to determine if remote sensing could be used as one source of these information "bits".

This guide, then, may be unique in two respects: (1) It documents functions and tasks on the basis of which to make decisions for effective and efficient relief action. We have not found these tasks clearly outlined elsewhere. These functions and tasks have been specified in diagrammatic form. These diagrams will be useful both to experienced personnel and to

those who have no previous experience upon which to rely; and (2) It suggests a new application of remote sensing technology for solving the problem of disaster management.

Disaster management and public health are linked in that both are concerned with the interaction of physical, social, and economic factors which aim towards restoring and maintaining the physical environment. Disasters interrupt systems necessary to maintain the public health. It is necessary not only to reestablish all the interrupted systems on which the protection of community health relies; but, to manage the potential and real public health problems during the period of reestablishment. The activities involved in doing this may seem from one perspective to have no relation to health, but from another perspective they are the underpinnings on which the health of a community depends.

Chapter 2

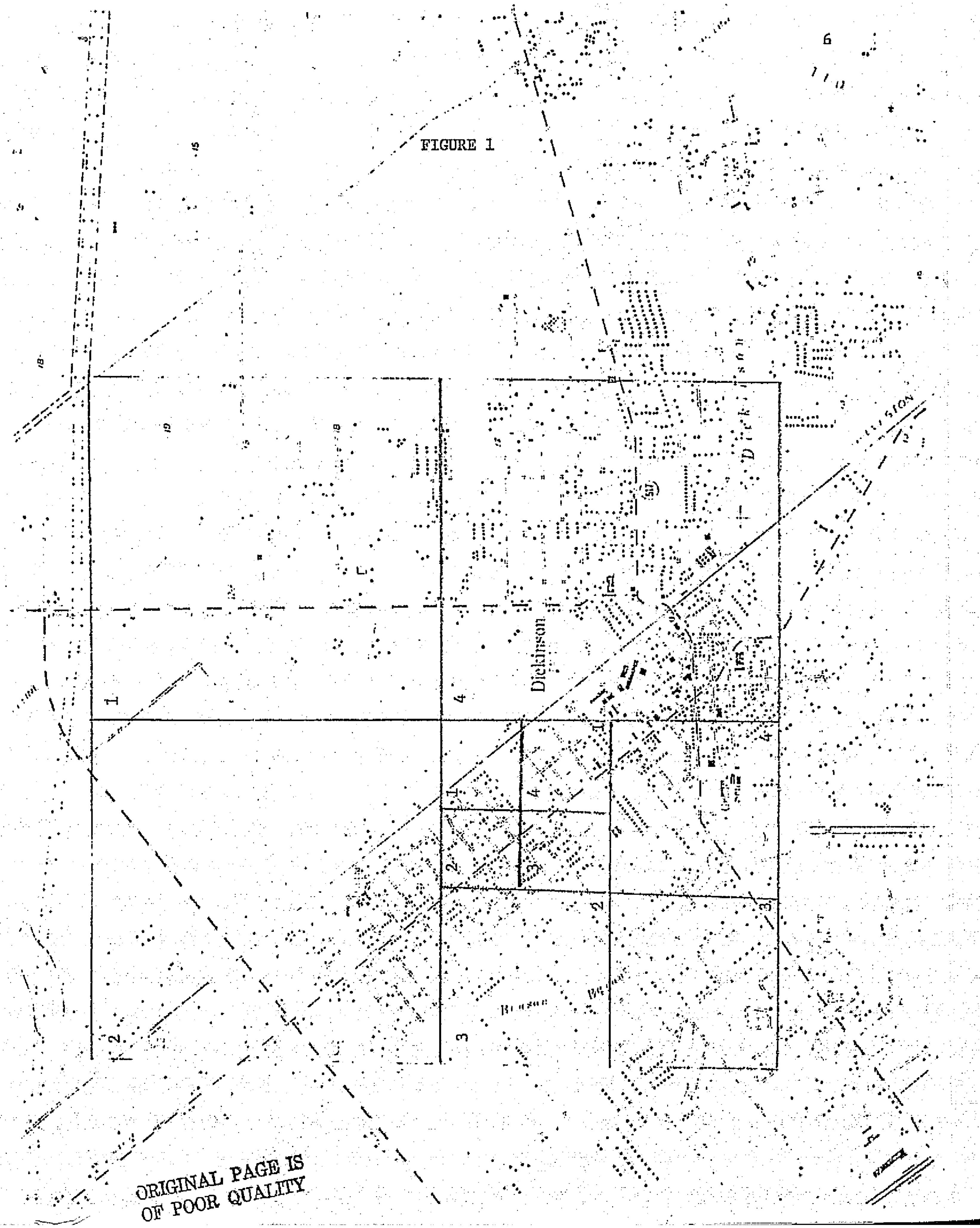
BASELINE DATA FOR PREDISASTER PLANNING

An important step in the process of analyzing the effects of a natural disaster is the comparison of the postdisaster situation with the predisaster status of the area. The collection and assimilation of information about the predisaster area is most desirable. Knowledge of how the specific systems operate and of what they consist when they are functioning properly will facilitate quicker identification of postdisaster public health problems. Baseline information about local systems should be compiled beforehand so it is readily available for use following a disaster. Checklists of suggested baseline data follow a description of each of the six systems of public health importance.

Baseline information includes basic demographic, land use, and topographical features of the disaster site. This information may be in map or interpreted photographic form along with tables of data. The data needed are revealed by the flowcharts of postdisaster activities. For example, to determine needed medical services, predisaster land uses and demographic characteristics of the affected area must be known so that the effects of the disaster can be more accurately assessed.

Not only must duplicate maps be available but they must have a common location system for every user. A grid should be drawn on each map and the grid squares numbered for easy reference (Figure 1). When a smaller area needs to be detailed, each grid can be further divided into four and then sixteen smaller grid squares (Figure 1, Grid 3). Numbering takes the serpentine format of survey systems.

FIGURE 1



A permanent and current set of data for key persons for each grid square would be optimum. This data set would include population, structure, and land characteristics. Examples of such data are number of children, total population, and institutionalized persons; numbers of dwelling units, day-time occupied structures, emergency public shelters; lowest and highest elevations, floodplains, levees and other ridges or high ground.

Networks such as water and sewer pipes, and streets and highways are not adaptable to tabular form and so maps of these systems, overlaid with grid squares, should be available to the disaster manager. A topical series of maps should also include hospital and emergency room locations, shelters, schools, and water pumping stations. Local disaster managers may determine other crucial sites in their communities for placement on maps.

Data Sources

Varied information can be acquired from predisaster aerial photography which has been interpreted. Planning commissions are also a source of land use and transportation information. City departments may supply water and sewerage system maps although a complete set for a large city may never have been assimilated. Other sources are State Highway Department (planning division), Forestry Department, Corps of Engineers district office, U.S.G.S., U.S. Department of Interior, NASA, or military organizations (such as Strategic and Tactical Air Command--SAC and TAC).

The Census of Population is a valuable data source for Standard Metropolitan Statistical Areas (SMSA's). The Census provides information on age groups in communities with greater than 50,000 population. Census

block group data break age into three groups for SMSA's: under age 18, 19-61, over age 62. This data would be available only by special survey in communities with fewer than 60,000 population. A Sanborn map series is available for most large cities and gives detailed information on commercial structures for insurance purposes. Some urban places have been surveyed by the American Red Cross. Not all sources are available for every community and not all sources keep the information current.

Tables of recommended baseline data follow short descriptions of each of the six management concerns. These are the optimum bits of information about each grid square which would prove helpful to disaster managers.

MEDICAL SERVICES BASELINE DATA

The normal operation of medical services requires that the major structures such as hospitals be intact and that staff be available to carry out routine procedures. Treatment of injury and illness following a natural disaster can be done more effectively and efficiently if everyday facilities are utilized and personnel, with a few exceptions (e.g., diversion of a few physicians to organize disaster activities such as triage), perform an augmentation of their normal everyday activities. Responsibility for treatment of injury and illness in the community belongs to the local medical society, and this remains true during and following a disaster.

A means of transporting the injured to treatment centers and a system for distributing them to appropriate facilities must exist. Efficient dispersement of injured in a disaster depends on (1) a system of communication so that changes in the receiving capability of local hospitals can be monitored and (2) information about the services offered and the resources available to the hospitals.

Three sets of data make up the recommended baseline information relevant to medical services. These consist of (1) land use, (2) population and (3) topography. These data provide a means (1) to estimate the type and number of injuries, (2) to assess the adequacy of medical resources, and (3) to delineate routes for transporting the injured to hospitals for treatment. All data should be recorded by grid square.

Land use

Land use information can be broken down into several categories such as Residential, Community Facilities, Industrial, Commercial, Open Space

and Other. The number of residential units gives an indication of the population if the number of people has not been determined by another method.

Important considerations may be age and quality of structures. These should be detailed enough so that injuries might be more accurately estimated. Past experiences in the community or in similar communities will suggest the most important variables such as age, construction material, etc. to organize baseline data.

Community facilities are usually located on small parcels and are scattered. These would best be shown on base maps. They are resources which can be called upon in disaster situations. Each hospital site should be listed separately with information regarding its capacity to handle disaster victims and the services it offers.

Industrial land uses should be identified and noted regarding any special situations in terms of hazardness. For example, chemicals may require special fire-fighting equipment. Strong winds may topple towers or injure storage tanks thereby creating a secondary hazard. An estimate of daytime and nighttime employment would help determine the population-at-risk of injury in a sudden disaster.

Commercial uses are important daytime activity centers and create a large population-at-risk.

Each community may wish to adjust the land use categories to reflect its own needs. Office space may be negligible in some communities, for example.

Population

The total population per grid square represents the population-at-risk. Sub-populations may need special provisions. Ethnic groups with

differing beliefs about medical services or food may be significant in number and should be noted in the baseline data. Other population classes such as age groups may be important.

Illness and injury unrelated to the disaster as well as cases from the disaster and from crowded shelter conditions must be considered. Pre-disaster disease information would be valuable although this would change more rapidly than other data. It would also tend to be more widespread than in discrete grid squares. If communicable health problems were known, the results of sheltering persons could be anticipated and needed supplies could be arranged early. School principals may be a current source of this base data. School personnel also serve as shelter managers because schools are frequently designated as shelters by the disaster-responding agencies.

Topography

A topographic map with elevations and important landforms would be useful in planning evacuations or movements to higher ground. Delineated floodplains are necessary to determine affected population, impassable roads and isolated community facilities at designated flood levels.

Grid Square #__________

TABLE 1

MEDICAL SERVICES DATA SHEET

Land Use	# Units	Population		
Residential				
Single	______	______		
Multiple	______	______		
Mobile homes	______	______		
Live-in institutions	______	______		
Hotels/Motels	______	______		
Community facilities (Mapped)				
Schools	______	______ (Enrollment & Staff)		
Fire stations	______	______ (Staff)		
Hospitals	______	______ (Capacity & Staff)		
Beds	______			
Emergency Services	______			
Power plants	______			
Industrial------------------------------------Employment Each Shift				
		A.M.	P.M.	Night
Heavy	______	______	______	______
Light	______	______	______	______
Commercial------------------------------------Daytime Population				
Retail	______			______
Office	______			______
Open Space			(Acres)	______
Other	______			______

(Medical Services Data Sheet Continued)

Population	# Units	Population
Total population		______
Ethnic groups		______
Other		______
____________________		______
____________________		______
Ages		
Adult (over 18)		______
Children		______
Institutionalized		______

Topography (Mapped)

Elevations

High ________ feet

Low ________ feet

Landforms

Floodplains

Lakes

Other

Topical maps: Schools, fire stations, hospitals, elevations and landforms.

WATER BASELINE DATA

For a modern water distribution system to function properly, electric power must be available to operate the well pumps and storage tank pumps, the major components of the system must be undamaged, and water must be potable. Components of the water system include wells, mains, water pumping stations, ground storage tanks, hydrants, and reservoirs. Responsibility for the maintenance and repair of the pumping and distribution system belongs to the Water Division of the Public Works or Services Department.

Determination of the suitability of drinking water sources may be made by chemical and microbiological means, or, where other methods are unavailable, by visual inspection. Depending on the source of the water, different treatment methods and degrees of treatment are used. For example, water from deep artesian wells may be safe to drink as it comes from the well or may require only slight chlorination. Water from other sources such as lakes may require more complex methods of treatment. Water is routinely checked for contamination throughout the distribution system, at the water plants, and at each well. Collection of water samples for determination of microbiologic contamination is usually done by both the Water Division and the Health Department. Responsibility of decontaminating the water usually rests with the Health Department.

Several kinds of information bits pertain to the water system. Wells, pumping stations, reservoirs, storage tanks, and hydrants are crucial points. It is practical to map all but hydrants as baseline data. Perhaps certain hydrants which are part of the subsystem serving other crucial points (eg., hospitals) could be pinpointed for special attention.

Grid Square #______________

TABLE 2

WATER DATA SHEET

Crucial sites

Wells

Pumping stations

Reservoirs

Elevated storage tanks

Hydrants

SEWERAGE BASELINE DATA

The operation of the sewer system is also predicated on the availability of electric power which is necessary to operate sewer pumps and treatment plants. Mains are another component of the system, but since they are for the most part gravity flow, electric power is not important to their operation. Where mains are gravity flow, treatment plants are located at a low point often near bayous and rivers to facilitate discharge of waste. Responsibility for the maintenance and repair of the sewer system usually rests with the Sewer Division of the Public Works or Municipal Utilities Department.

The locations of treatment plants and sewer pumps are important sites to have pre-marked on maps. These are two major parts of the sewerage system. Although sewer mains are vital to functioning, they are underground and therefore invisible to the eye. Nevertheless, a map of this system may prove useful.

Grid Square # ________________

TABLE 3

SEWERAGE DATA SHEET

Crucial sites

Collection plants

Treatment plants

Sewer pumps

Light Stations

Sewer mains

SHELTER BASELINE DATA

The residential units of an area provide shelter for a relatively permanent population. In addition to those living in dwelling units, others reside in nursing homes, dormitories, prisons and other institutions. Persons who are traveling or are between residences may be staying at hotels and motels. Other temporary quarters may be hospitals and jails. Few persons in this country lack shelter and are found living in the streets.

When the normal living system is disrupted, temporary quarters need to be established as on a public service basis. Some persons may have the resources to obtain substitute shelter for themselves, but the majority will be helpless without organized relief efforts.

The persons potentially in need of shelter include both the residential and institutional populations. Those residing in specialty quarters would need special provisions such as extra nurses, guards, or other equipment. Moving these persons to another similar facility might be better than relocating them to a shelter if transportation exists.

Persons who have been dislodged from dwelling units, hotels and dormitories can be relocated to nearby shelters. Estimates of the numbers that might require shelter should therefore be kept current for the grid square areas. If an entire grid area suffers damage or is inundated, the total population will need shelters. An area may be so badly damaged that estimates could not be made from the debris. In this case, only knowledge of the predisaster situation could give an accurate account of the problem.

Critical information includes both the normal situation and the postdisaster situation. It is the difference between the number of housing units standing predisaster and the numbers standing after the disaster

which most accurately assesses the damage. Without baseline information, postdisaster data will be less reliable.

Potential shelter sites are usually identified in advance in case emergency housing is needed. Schools and churches are most often designated as shelters since each neighborhood contains at least one such facility at the time of a disaster. These sites need to be noted on the standard maps so selection of appropriate ones (e.g., those undamaged and closest) can be made. Other sites, which could be designated as shelters if needed, should also appear on the maps. These may be structures servicing large daytime populations such as office buildings, libraries, college campus buildings, etc. Those best suited would have large spaces for sleeping arrangements, multiple restrooms and perhaps kitchen facilities.

The capacities of shelters and the numbers of residential units forms part of the baseline data for shelters. The estimated daytime and nighttime populations completes the recommended baseline information (See Table 4).

Shelters present additional community health problems due to crowding, disruption of procedures conducive to good personal hygiene, etc. Under these conditions communicable diseases can spread with great ease.

Grid Square #______________

TABLE 4

SHELTER DATA SHEET

Designated Shelters (mapped)

Capacity

Supplementary Emergency Shelters (mapped)

(other buildings capable of emergency use)

Capacity

	# Units	# Population
Residential		
Single		
Multiple		
Mobile homes		
Live-in institutions		
Hotels/motels		

FOOD BASELINE DATA

Food handling establishments in a community include grocery stores and warehouses. Restaurants also maintain a stock of food on the premises. Food supplies are continually being shipped into cities and with total disruption of this system the supply at any one time would last only a few days.

Special subgroups of the population may need special foods. Sources of baby food and other canned goods would be valuable baseline information. Fresh fruit and vegetables will not be edible after a few days without refrigeration so these sources would be useful for only a short time.

Pre-designation of major food handling establishments and other food supply sources need to be made on maps. Other data required for determining its edibility would include knowledge that the power system was working and that the storage buildings were intact.

Grid Square #________________

TABLE 5

FOOD DATA SHEET

Crucial Sites

Grocery warehouses (mapped) # and square footage

Grocery stores (mapped)

Restaurants

Power plants (mapped)

Topography (mapped)

TRANSPORTATION BASELINE DATA

Transportation routes and communication lines are of major importance to the proper functioning of a community. It is these systems which allow interaction of persons and make necessary services accessible.

The conditions and capacity of major transportation routes should be predetermined. A listing of each essential route, bridge, airport and other critical points should be available.

A map of major auto and rail arteries is the best form of recording their location. Airports, heliports, and water routes may also be of local importance. These may be located by symbol or number on transportation map(s). Route capacity (e.g., number of lanes) can be indicated on a map by relative line widths.

Grid Square #________________

TABLE 6

TRANSPORTATION DATA SHEET

Auto

Bridges

____

____

Major arterials

____

____

Railroad

Bridges

Tracks

Terminals

Airports

Runways

Terminals

Access

Limitations

Construction Material

Chapter 3

DECISION MAKING IN THE IMMEDIATE POST DISASTER RELIEF PERIOD

Flow diagrams were constructed of the major disaster relief decisions within each of six general areas of public health concern (Figures 2-7). Community health, as discussed in Chapter 1, rests on the smooth functioning of certain service systems. The systems which are necessary to maintain community health include: medical services, water, waste disposal, shelter, food, and transportation.

These diagrams are linear, that is, various tasks are ordered sequentially according to priorities. However, relief activities for the most part have a web-like structure in which many things go on concurrently. Therefore it must be kept in mind that the starting point for each of the diagrams is either predisaster planning or immediately postdisaster. In addition, tasks on a single diagram not only may but should go on simultaneously. For example, repair of the water facilities may go on concurrently with distribution of water.

Major decisions that need to be made in each area are identified by a diamond symbol on the figures. Information needed to make these decisions is enclosed by rectangles. Alternative ways of acquiring some of this information is circled. Each work function is briefly described followed by the flow diagram of that function. A summary sheet stating how remote sensing might aid these work functions is also included.

MEDICAL SERVICES

The major decisions which need to be made to perform this function are: (1) Is there a need for emergency medical attention?, (2) Can medical attention be handled locally?, and (3) Are local facilities and supplies adequate? (Figure 2). The main information "bits" needed in order to provide medical care are an estimate of the number and type of injuries and illness, an assessment of the adequacy of available supplies and resources, and if necessary, a knowledge of where supplementary facilities and supplies may be obtained.

There appears to be no systematized reporting or recording of injuries following natural disasters. The organization or group which runs the ambulance service is in the best position to know numbers and types of injuries. In most cities ambulance service is privately owned and operated, but in some cities, like Houston, Texas, it is run by a city agency such as the Fire Department. An unofficial estimate of illnesses and injuries is made by the Red Cross based on the number of cases occurring in the shelter population, but initial estimates are not very accurate.

Responsibility for treatment of injury and illness following natural disasters generally belongs to the local Medical Society and sometimes to the Department of Public Health. The responsibility of the Red Cross in the area of medical services is limited to treatment of emergency medical problems occurring in the shelters they staff. Physicians and other medical personnel in the private sector may or may not be organized to the extent of having prepared an SOP. For the most part their tasks in a disaster are the same as their everyday activities but on an augmented basis:

more personnel may be required to be on duty to handle the increased number of injuries and illness.

With or without an SOP, the effectiveness of this group depends on the sophistication of the communications network available to them. Persons in charge of triage in the field need to communicate with the hospitals in the area in order to be informed of what resources are available at various institutions (e.g., some hospitals may be better equipped to treat burns than other hospitals) and to be informed of their capacities.

Most hospitals have inventories of their supplies and information about their resources and capacities, but there is no central source for obtaining this information for all hospitals in a given geographic area. SOP's might be a useful means of centralizing this information for integrating it into disaster plans. It is generally the responsibility of the Health Department to ascertain resource availability information and to establish resupply requirements. The SOP for this agency could be expanded to include this additional information.

The following table summarizes the capability of remote sensing to provide information concerning the problem area of medical services.

MEDICAL SERVICES & REMOTE SENSING

Remote sensing can, with baseline data, supply the following:

(1) extent and nature of residential damage (Multiple, Mobile homes)

(2) extent and nature of commercial damage

(3) extent and nature of industrial damage

(4) extent and nature of medical facilities damage

(5) extent and nature of utilities damage

(6) extent and nature of open transport routes and present capacity.

The above information would allow a disaster manager to do the following:

(1) estimate areas of potentially most severe, medium severe, and least severe injury levels

(2) determine optimum locations of first aid stations and field hospitals

(3) determine distribution system for injured to hospitals or other medical facilities

(4) determine routes to receive supplementary supplies or personnel.

Without baseline data, Remote Sensing would be useful in supplying the following information:

(1) extent and nature of residential damage (apartment buildings, mobile homes)

(2) extent and nature of commercial damage

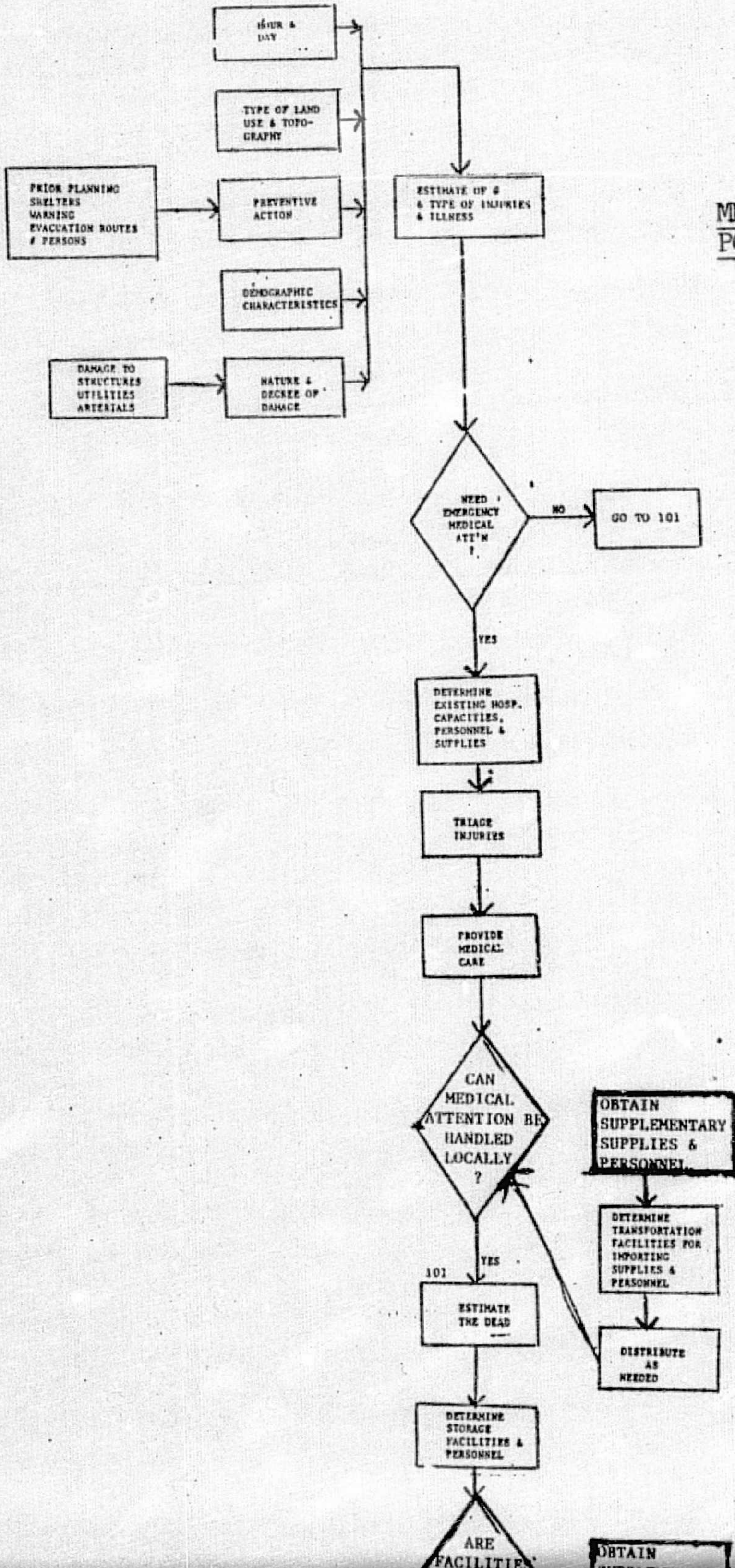
(3) extent and nature of industrial and warehouse facilities damage (combined)

(4) open transport routes and present capacity

FOLDOUT FRAME

FIGURE 2

MEDICAL ATTENTION POST-DISASTER



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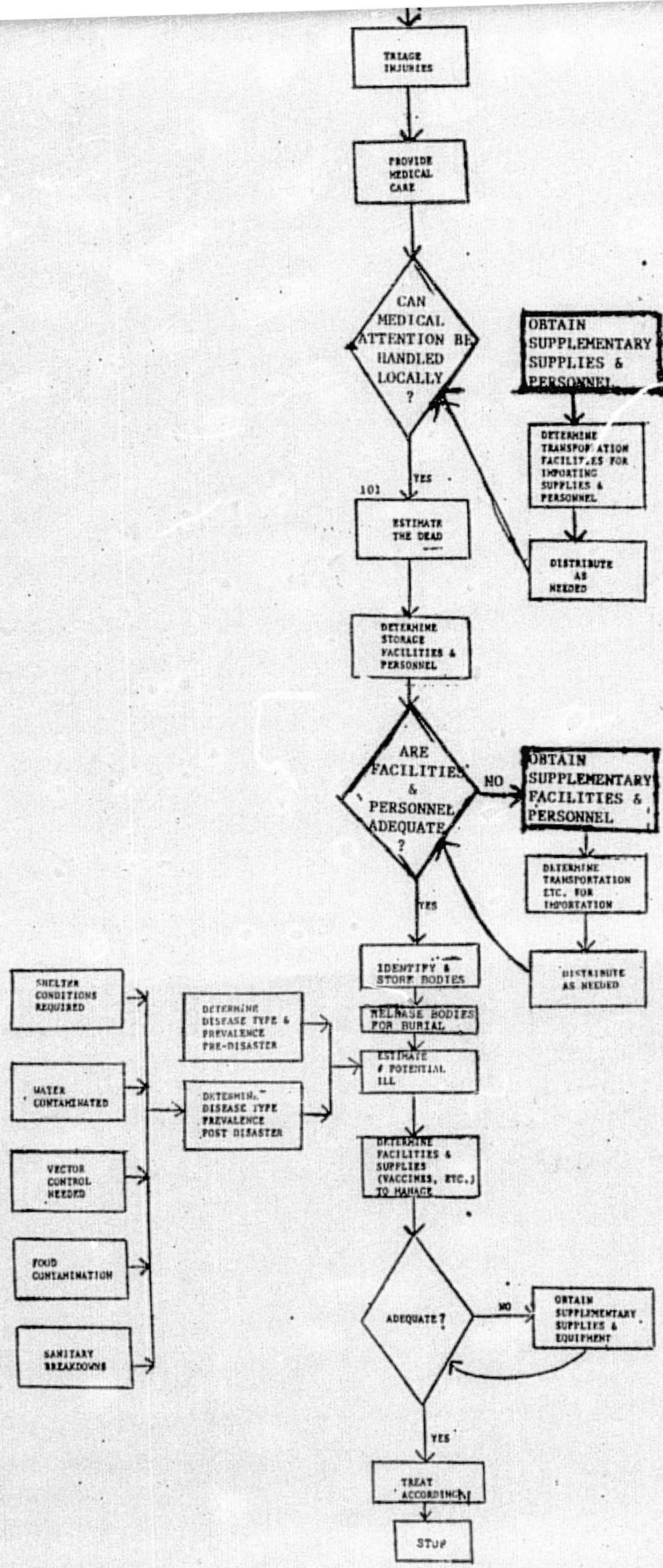

TRIAGE INJURIES
PROVIDE MEDICAL CARE
CAN MEDICAL ATTENTION BE HANDLED LOCALLY ?
OBTAIN SUPPLEMENTARY SUPPLIES & PERSONNEL
DETERMINE TRANSPORTATION FACILITIES FOR IMPORTING SUPPLIES & PERSONNEL
DISTRIBUTE AS NEEDED
YES
101
ESTIMATE THE DEAD
DETERMINE STORAGE FACILITIES & PERSONNEL
ARE FACILITIES & PERSONNEL ADEQUATE ?
NO
OBTAIN SUPPLEMENTARY FACILITIES & PERSONNEL
DETERMINE TRANSPORTATION ETC. FOR IMPORTATION
DISTRIBUTE AS NEEDED
YES
IDENTIFY & STORE BODIES
RELEASE BODIES FOR BURIAL
ESTIMATE # POTENTIAL ILL
SHELTER CONDITIONS REQUIRED
WATER CONTAMINATED
VECTOR CONTROL NEEDED
FOOD CONTAMINATION
SANITARY BREAKDOWNS
DETERMINE DISEASE TYPE & PREVALENCE PRE-DISASTER
DETERMINE DISEASE TYPE PREVALENCE POST DISASTER
DETERMINE FACILITIES & SUPPLIES (VACCINES, ETC.) TO MANAGE
ADEQUATE ?
NO
OBTAIN SUPPLEMENTARY SUPPLIES & EQUIPMENT
YES
TREAT ACCORDINGLY
STOP

WATER

There are five major decisions which need to be made concerni... he problem area "water." They include (1) Is the pumping and distribution system operating?, (2) Is power available to operate the pumps?, (3) Is the water contaminated?, (4) Is potable water available?, and (5) Are supplementary water supplies needed? (Figure 3). In time of disaster, information to perform these tasks is usually gathered by field survey.

Repair of the pumping and distribution system involves checking the major elements of the system which includes wells, mains, water pumping stations, ground storage tanks, hydrants, and reservoirs. Water mains are, for the most part, underground and so are not affected by hurricanes and floods. The exception to this is where mains cross bayous or rivers. Here, wind damage due to tornadoes might result. Where wells are in low areas, flooding might be a problem. In areas of severe flooding, relief workers might not be able to get into an area to check or repair the system. The Water Division of the Public Works Department is usually the agency responsible for performing these tasks, and a preliminary check of the system following a natural disaster takes approximately one day.

If the water distribution system is inoperative due to damage of the system or to contamination, water must be furnished and distributed. In order to do this, three information "bits" are required: (1) an estimate of the population in need of water and the duration of this need, (2) a method of supplying water, and (3) a determination of the local facilities and supplies. Water distribution is generally the responsibility of local government but is sometimes handled by the Red Cross.

WATER & REMOTE SENSING

With baseline data, a photo interpreter can identify the following:

(1) wells

(2) pumping stations

(3) reservoirs

(4) elevated storage tanks, and

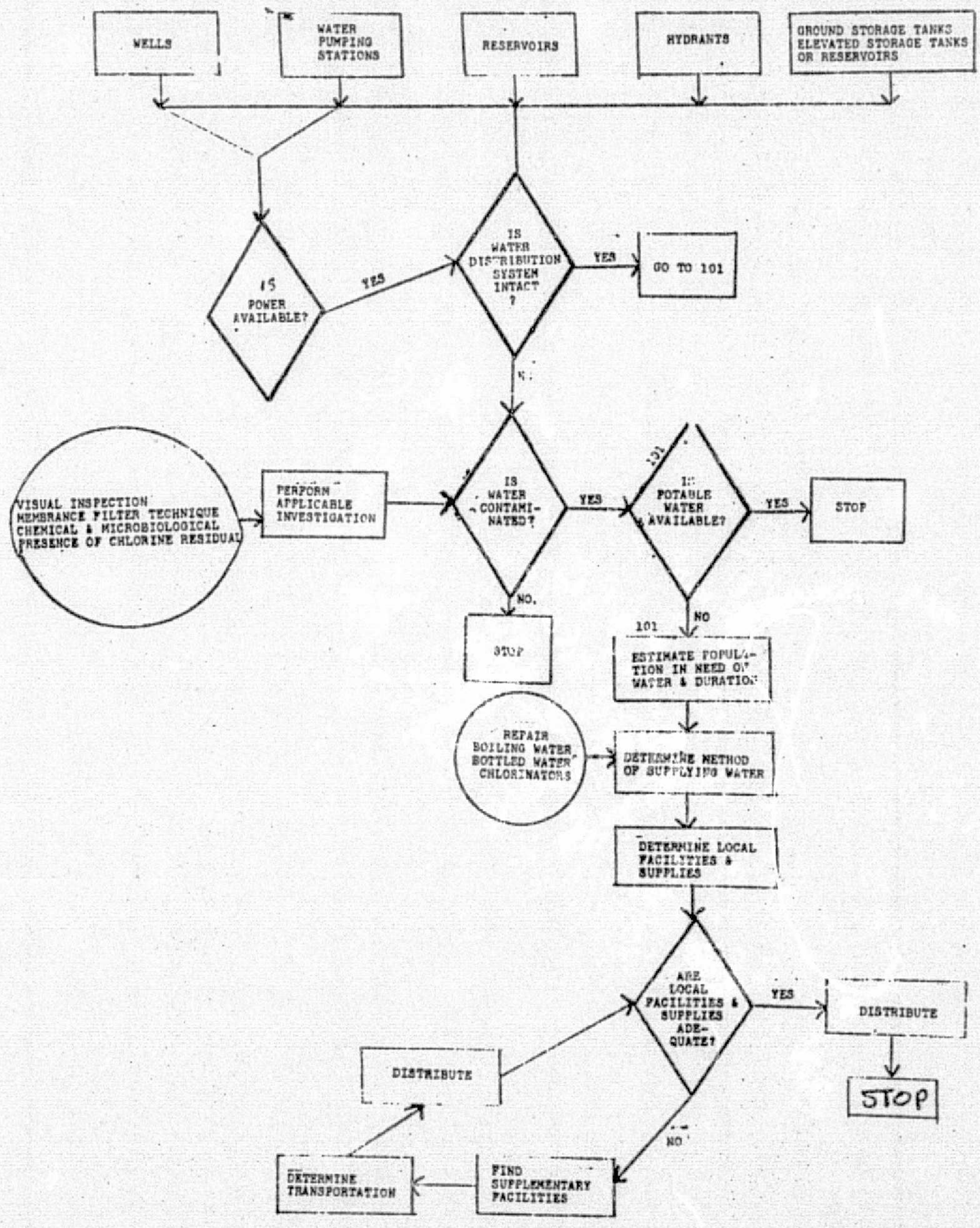
(5) hydrants.

The nature and extent of damage to these is detectable.

Without baseline data, reservoirs and elevated storage tanks would be recognizable unless damage had demolished them beyond recognition.

FIGURE 3

WATER



SEWERAGE

Three major decisions need to be made for this task: (1) Is the sewer system (treatment plants and collection system) working?, (2) Is there a need for supplementary facilities?, and (3) Are these facilities available easily? (Figure 4). This information is usually gathered by field survey. Components of the sewer system which need to be checked postdisaster are the treatment plants, mains, and pumps. As with water, the operation of the treatment plants and sewer pumps depends foremost on the availability of electric power.

Mains for the most part are gravity flow so the treatment plants are usually located at a low point. Treatment plants are generally situated near bayous and rivers so that waste may be easily discharged. For these reasons, plants may be prone to flooding. Sewer mains may become blocked by trash and flood water, and breakage may occur at tressle crossings where mains cross bayous or rivers although this is rare since most mains are underground. Pumps may be damaged by wind if they are above ground, while those housed in vaults are more vulnerable to flooding.

In disasters, problems associated with treatment plants and pumps are discovered first while those associated with mains are found last, often by citizens' reports. In Houston after Carla it took about three weeks to locate all the problems with the sewer system.

If it becomes necessary to supplement or temporarily replace the regular sewer system, three "bits" of information are needed: (1) an estimate of the population in need of alternate sanitary methods, (2) the distribution of the population in need, and (3) a determination of the local facilities and supplies. These activities are generally handled by local government sometimes with the help of the Red Cross.

One way of conceptualizing these tasks might be on a societal versus an individual level. For example, the Sewer Division is concerned with reestablishing the integrity of the system as a whole for permanent use while other agencies such as the Red Cross are concerned with meeting the sanitary needs of individuals on a temporary basis.

SEWERAGE & REMOTE SENSING

With baseline data remote sensing information obtainable from low level aerial photography includes the following:

(1) nature and extent of damage to collection and treatment plants

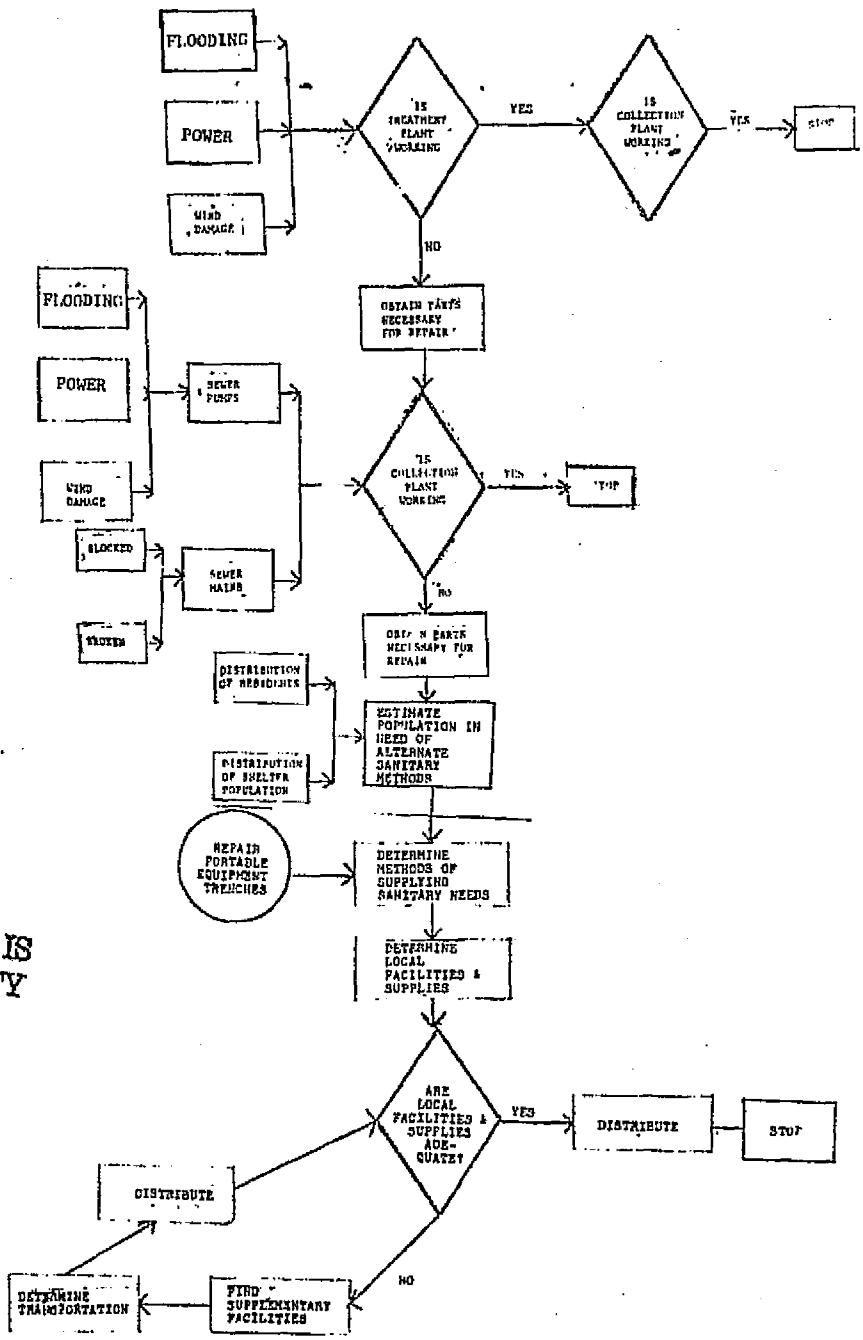
(2) nature and extent of damage to sewer pumps if above ground

(3) routes for bringing in equipment and alternate facilities.

Without baseline information aerial photography would be limited in its usefulness. Treatment plants are potentially identifiable. Routes for bringing in alternate facilities can be designated.

FIGURE 4

SEWERAGE



SHELTER

(1) Are shelters needed?, (2) Are shelters accessible?, (3) Are they damaged?, and (4) Is the capacity adequate? (Figure 5). The information "bits" needed to make these decisions include: (1) information about whether transportation routes to shelters are open, (2) an assessment of the degree of damage to shelters, and (3) an estimate of the population requiring shelters and the duration.

Some information is collected on a daily basis during a disaster by Red Cross volunteer field surveyors. Statistics on the number of dwellings destroyed, the number of dwellings with major and minor damage, the number of persons sheltered, and the number of shelters opened are gathered. Since these estimates are revised daily, a more or less accurate picture of damage and persons requiring shelter ultimately emerges. What would be more useful, however, is an early accurate estimate of the number of persons requiring shelter so decisions about the number and location of shelters needed and the amount of resources to bring into an area could be made.

The kind of land use affected by a disaster will influence the numbers of people needing temporary housing. For example, if industrial or commercial areas were damaged, then housing would not likely be needed. The amount of damage to residences will determine if long-term supplemental housing needs to be brought to the community. Mobile homes may serve this purpose.

A disaster may do more harm to less sturdy buildings. Therefore, the rate of demolished homes may be higher in some areas than in others. This may be extended to a higher rate of injury or to higher rates of shelter use, thereby requiring more food and water.

Shelters provide short-term housing. The nearest undamaged shelters to the stricken area should be chosen for ease of movement. Information about utilities might affect this decision, however. Shelters located where power and water are available might be more appropriate, depending on community resources to either move persons or provide food and essential services without power and water.

The number of shelters opened will depend on the size of population affected. If persons had been evacuated, then the number will be reduced. If a widespread area is involved, several shelters may need to open because of inaccessibility to one. Shelter location should be checked against topography to insure that they are accessible in case of high water.

Shelters near the stricken area can be found on the aerial photographs to determine if they suffered damage. If none is apparent, these shelters would be the first to open. If damaged, other shelters need to be identified and the routes to them determined.

An accurate assessment of the number of dwelling units remaining or the number damaged in a grid area can be determined by aerial photo interpretation to decide if shelters are needed. Estimates of population in search of temporary shelter can be based on the numbers of residential units and group quarters needing to be evacuated.

The geographical extent of the affected area and broad degrees of damage can be determined rapidly. This information would be vital to the choice of shelter locations and for determining the number required to house the estimated population.

If shelter sites have been noted on maps, they can be identified on the postdisaster photos to determine if damage has occurred to them and

if they are accessible from the stricken area. A summary table appears on the following page.

Transportation routes affecting shelter supplies can be examined for blockage in addition. Supplies for shelters are frequently organized by the Red Cross. Local purchases may be made and military supplies may be requested. Responsibility to furnish and staff its shelters usually belongs to either local government or the Red Cross.

SHELTER & REMOTE SENSING

With baseline data remote sensing can supply the following information:

(1) extent of residential damage per grid square

(2) nature and degree of residential damage

(3) accessibility of shelters

(4) extent and nature of damage to shelters

Without baseline data remote sensing can help determine:

(1) extent of residential damage

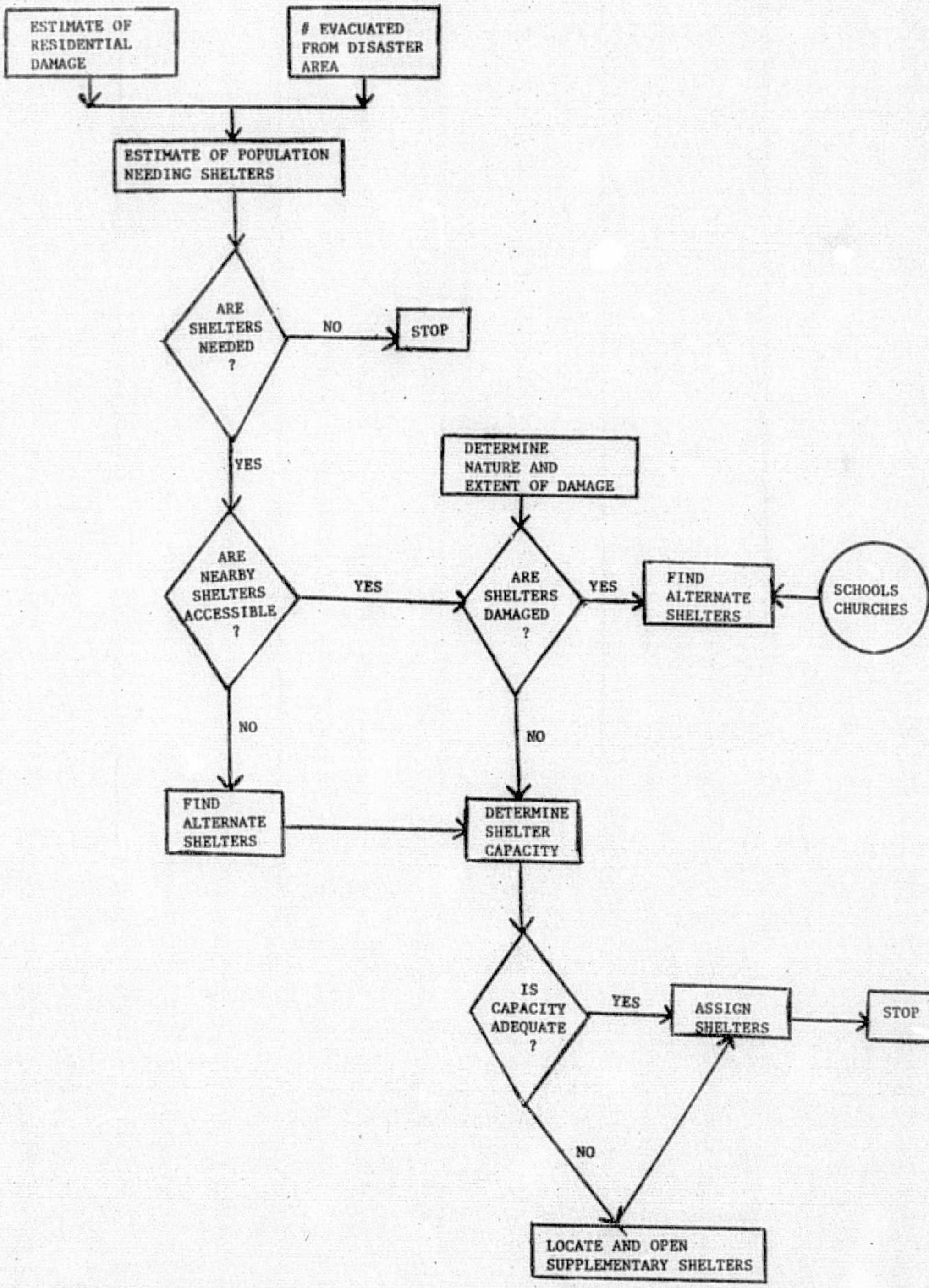
(2) nature and degree of residential damage

(3) location of schools and other potential sites for shelters

(4) accessibility to potential shelters

FIGURE 5

SHELTER



FOOD

Two major decisions need to be made to maintain the food supply: (1) Is the local food supply sufficient? and (2) Is the food supply contaminated? The information "bits" needed to make these decisions include: (1) an estimate of the number of people who need to be fed and the duration of this need and (2) an estimate of the quantity of food locally available for use.

Determination of the suitability of food supplies may be made by chemical and microbiologic means or by visual inspection, e.g., submerged or bulging canned goods. Responsibility to test for food contamination usually lies with the City Health Department as does responsibility for disposing of contaminated food. An estimate of the food supply damage is usually made by the U.S. Department of Agriculture. Estimating the population in need of food is generally the responsibility of the Red Cross sometimes with the assistance of the Health Department or the Welfare Department. It is the responsibility of local government to obtain, transport, prepare, and distribute food or to arrange for these things to be done. Sometimes the Red Cross is called on to help perform these tasks. Supplies such as field kitchens may be requested from the military. Transporting food to the disaster site when necessary is also done by the Red Cross and may be accomplished in one of several ways: (1) the National Defense Transportation Association (NDTA) can transport goods via air, sea, land or rail. In disasters, they transport goods for the government and the Red Cross at no charge; (2) the military may furnish vehicles; (3) the Red Cross may furnish vehicles; and (4) vehicles may be rented.

To determine whether food is contaminated and whether there is an adequate supply, several kinds of information are needed. The condition of food storage establishments must be determined. Roof damage and litter can be identified as well as flood inundation.

If an establishment suffers from structural damage, then food may not be available from it. Water inundation would contaminate fresh or packaged food and canned food may also be harmed. It is safest not to use canned goods that have been submerged for any length of time. Refrigerated or frozen food will be rendered useless in a matter of hours if power is interrupted. Power plants and substations can be checked for damage and inundation. Such disruptions can be identified with the aid of photography in disaster-stricken communities.

The supply of uncontaminated food must be assessed in relation to the demands upon it. The number of persons and length of time constitute the drains on food supply. An estimate of persons can be made from the sheltered population and from the dwelling units without power but sheltering persons. Special food requirements can be estimated by population age structure and by cultural groups affected. For example, infants require different food from adults.

The table on the next page summarizes the capability of remote sensing in the function area of food.

FOOD & REMOTE SENSING

With baseline data remote sensing can supply the following information "bits" about food handling establishments:

(1) extent of structural damage to food handling establishments, power plants and residential* land uses

(2) nature of damage (e.g., inundation, collapse)

(3) accessibility to critical points (e.g., shelters, hospitals)

(4) those establishments which should be ground checked for food contamination

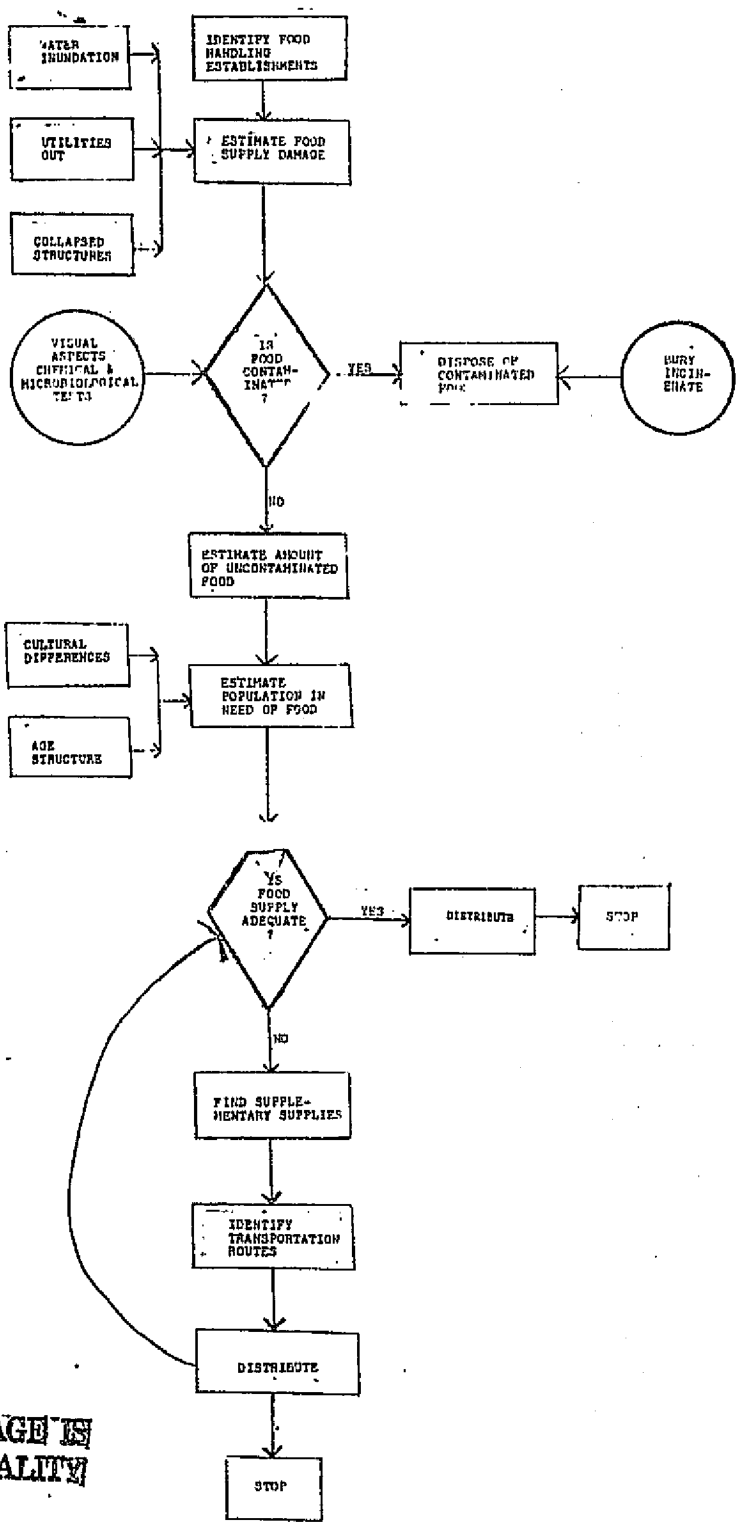
(5) transportation routes to receive supplementary supplies

*Residential includes live-in institutions

Without baseline data, food warehouses would not be easily identifiable. Some grocery stores and restaurants may be recognizable by local persons familiar with the area.

FIGURE 6

FOOD



TRANSPORTATION

Implementation of some phases of all relief activities probably involves access to transportation routes. Checking the water and sewer systems, distributing food and water, carrying out rescue operations, providing medical care, and making shelters accessible all depend on open transportation routes and on some means of transportation.

A great deal of preplanning is necessary to e. ectively execute the tasks outlined on this diagram. For example, arrangements must be made to obtain vehicles and sufficient fuel for them and to perform maintenance operations. In addition, vehicles must be allocated for various tasks such as evacuating people prior to the disaster when possible, moving material (clothing, food, medical supplies, etc.) within the disaster area, and debris clearance. Evacuation routes may also be predetermined and revised if necessary.

Postdisaster, there is an immediate need to determine the condition of major transportation routes and, if necessary, to assign priorities for clearing them and/or to designate alternate routes. Controlling the movement of traffic in and around the disaster area, while generally a law and order function, interrelates with designating accessible routes as does coordination of ambulance service to the area.

A map and list of essential points in the transportation system would facilitate a survey of usable routes. The sites could be spotted on postdisaster photos and an assessment of conditions could be made.

With baseline data the following could be supplied by aerial photos:

(1) condition of routes, bridges, railroads, terminals, runways

(2) blockage points in system.

With this information and an overview of the area, routes could be determined which could avoid delays by ambulances, firetrucks and other relief vehicles.

Without baseline data, the same information could be realized but at a greater expense of time.

FIGURE 7

TRANSPORTATION

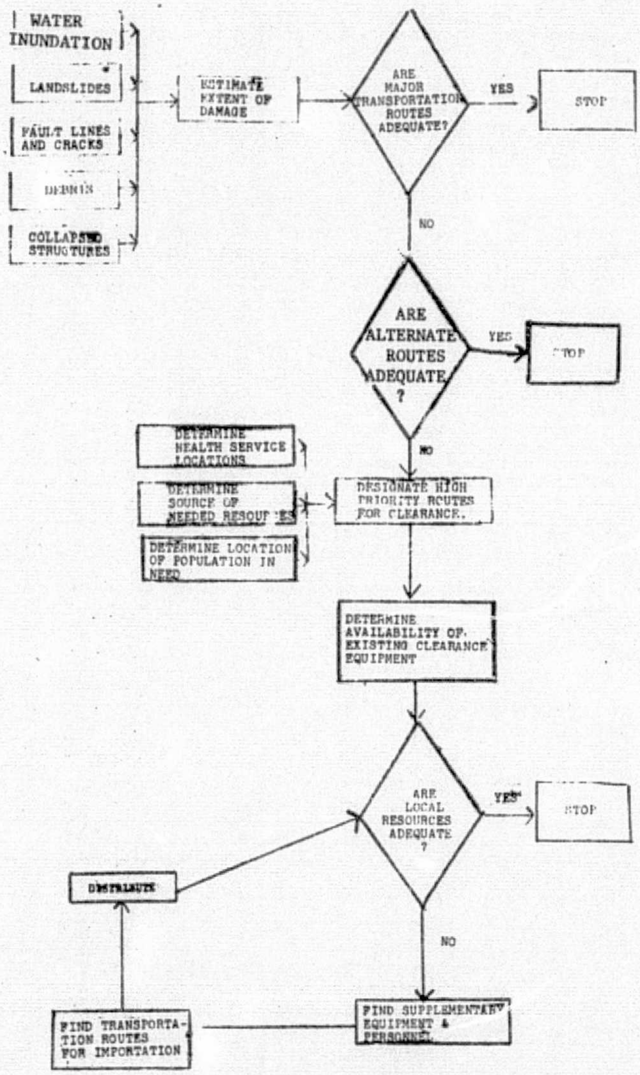
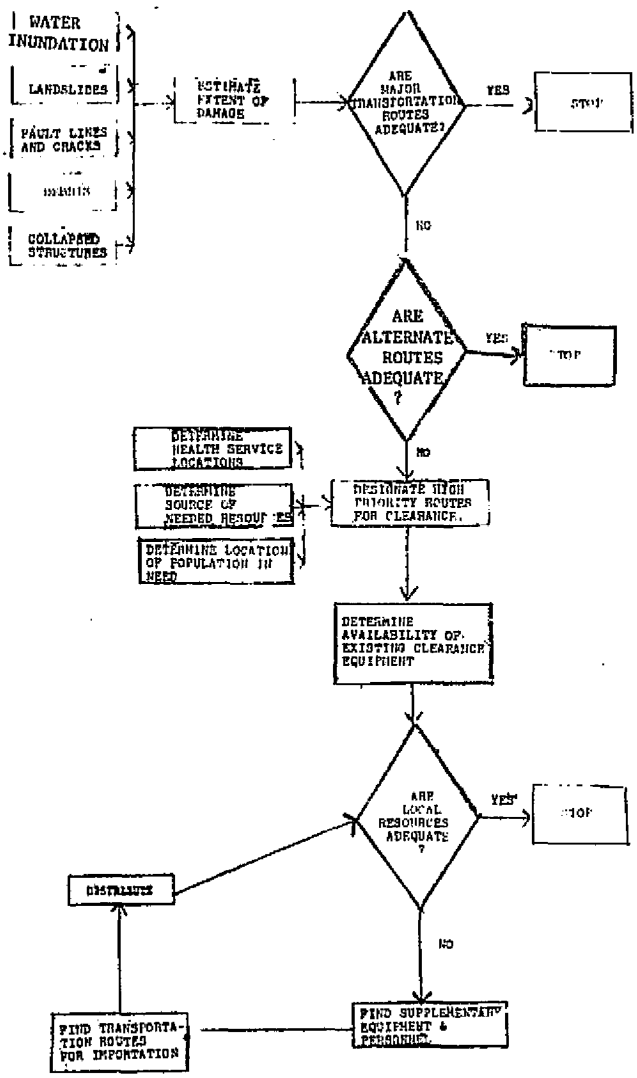


FIGURE 7

TRANSPORTATION



Chapter 4

REMOTE SENSING: A SUPPLEMENTARY MEANS OF DATA GATHERING FOR DISASTER RELIEF

Introduction

Collection of information following natural disasters is done primarily by the process of field survey. However, most of the data is not obtained, recorded, processed, and analyzed in a systematic way. In a survey only one agency--the Red Cross--could be found which has a form for recording information and does so systematically following natural disasters. (See Form A.) Collection of this information could be useful to persons concerned with several of the functions described in Chapter 3 if information could be accumulated, analyzed, and interpreted early in the acute relief process. In fact, the information they collect is often exchanged with city, state, and federal relief agencies.

The field survey procedure leads eventually to accurate and complete data; however, in a large disaster, this process may take several weeks. For example, the Red Cross gathers information on number of persons dead, with injuries or illness, and hospitalized as a result of the disaster. If early, accurate estimates of this data could be made, the provision of medical services could be managed more efficiently. Information on degree of damage to residential structures (single-family dwellings, mobile homes, and apartments) and to small businesses is also collected. Timely information on extent of damage would enhance accurate estimation of the number of shelters and the amount of food required to service the population in the disaster area. Information pertaining to the recovery of other functions such as water and sewerage is also currently gathered by the time-consuming method of field survey.

THE AMERICAN NATIONAL RED CROSS

STATISTICAL AND COST REPORT OF DISASTER OPERATION

PAGE ____ OF ____ PAGES

ESTIMATE: ☐ 1st ☐ 2nd ☐ 3rd

☐ FINAL FIELD

THIS SPACE FOR USE OF NATIONAL OFFICE ONLY					
TYPE DR.	DATE	SERIAL NO.	FISCAL YEAR	IDENT. CODE	ADMIN.

KIND OF DISASTER	DATE OF DISASTER	NAME OF OPERATION	NUMERICAL CODE	ADMIN. SETUP

DISASTER AREA:	NAME ▶						
	DIVISION CODE ▶						
	CHAPTER CODE ▶						

LOSSES	PERSONS	DEAD	01						
		WITH INJURIES OR ILLNESSES	03						
		HOSPITALIZED	05						
	DWELLINGS	DESTROYED	07						
		WITH MAJOR DAMAGE	09						
		WITH MINOR DAMAGE	11						
		APPROXIMATE % INSURED	13						
		APPROXIMATE % OF VALUE INSURED	15						
		APPROXIMATE % OWNER OCCUPIED	17						
	MOBILE HOMES	DESTROYED	19						
		WITH MAJOR DAMAGE	21						
		APPROXIMATE % INSURED	23						
	APARTMENTS, CONDOMINIUMS, ETC.	FAMILY UNITS DESTROYED	25						
		FAMILY UNITS WITH MAJOR DAMAGE	27						
		FAMILY UNITS WITH MINOR DAMAGE	29						
	SMALL BUSINESSES	DESTROYED AND WITH MAJOR DAMAGE	31						
	TOTAL FAMILIES SUFFERING LOSS		33						
ASSISTANCE	MASS CARE TOTALS	NUMBER OF SHELTERS	35						
		PERSONS SHELTERED	37						
		VICTIMS AND WORKERS GIVEN MASS CARE	39						
	NUMBER OF FAMILIES GIVEN INDIVIDUAL CARE	FOOD, CLOTHING, AND MAINTENANCE	41						
		BUILDING AND REPAIR	43						
		HOUSEHOLD FURNISHINGS	45						
		MEDICAL AND NURSING	47						
		OCCUPATIONAL SUPPLIES AND EQUIPMENT	49						
	TOTAL FAMILIES APPLYING FOR ASSISTANCE		51						
	TOTAL FAMILIES ASSISTED		53						
	DWELLINGS REBUILT		55						
	DWELLINGS REPAIRED		57						
COSTS	FOOD, CLOTHING, AND MAINTENANCE		59	$					
	BUILDING AND REPAIR		61						
	HOUSEHOLD FURNISHINGS		63						
	MEDICAL AND NURSING		65						
	OCCUPATIONAL SUPPLIES AND EQUIPMENT		67						
	TOTAL INDIVIDUAL FAMILY CARE (Items 59 through 67)		69	$					
	EMERGENCY MASS CARE		71						
	TOTAL RELIEF (Item 69 plus Item 71)		73	$					
	ADMINISTRATION		75						
	SERVICE COSTS		77						
	TOTAL (Item 75 plus Item 77)		79						
	TOTAL COST OF OPERATION (Item 73 plus Item 79)		81	$					

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DATE PREPARED	SIGNATURE	TITLE

AMERICAN RED CROSS FORM 2066 (Rev. 3-78)

Initial estimates of damage in a large disaster such as a hurricane are made by the Red Cross using Census data. Obtaining an estimate takes from 24-48 hours. As soon as conditions permit, teams composed of volunteers survey the area and assess damage scored as major or minor on a house to house basis. Some information items are obtained from other agencies such as police, fire, civil defense, and insurance companies which make counts of certain items on the Red Cross form. This process usually takes about 1,000 volunteers 2 or 3 weeks to survey a city the size of Houston. If more volunteers were available, the initial stages of the survey--such as identification of the communities affected--could be expedited, but completion of the survey would still require about 3 weeks.

The amount of time required to compile an estimate of the number of ill, injured, hospitalized and dead depends on the availability of communication service as well as on the number of volunteer nurses. It would take 3 to 5 Red Cross nurses 3 or 4 days to make these estimates following a major hurricane in a large city.

A need exists for a method of gathering and analyzing data quickly following a natural disaster. This data would enable disaster managers to make decisions based on accurate timely information and thus their actions can be related more specifically to circumstances in the postdisaster environment. This chapter proposes an alternate or supplemental means of data gathering called remote sensing.

What is remote sensing? What is its role in disaster management?

Remote sensing is "the acquisition of information about an object (or phenomenon) which is not in intimate contact with the information-gathering device" (Parker and Wolff, 1973). It is a means of extending our

structures. In most cases the type of structure can be identified and the amount and type of visible damage can be assessed (Table 7).

5. The capability to review in much more detail at a later time things that may be overlooked in other initial surveys.

6. The availability of a permanent record of the damage.

7. The only means of obtaining information when ground truth or field survey is not possible.

The altitude of the plane and the focal length of the lens allow for variations in the scale of the photographs. By manipulating these variables it is possible to obtain large scale or close-up views or an overall view of an area.

Although the pattern of damage may vary with the type of natural disaster, this does not affect the process of photo interpretation. The same system can be utilized for any natural disaster which results in observable, physical damage.

TABLE 7

Type of Facility	Identification Probability
1. Structural Damage	
Community facilities	
Hospitals and medical	75%+*
Schools	90%+
Churches	90%+
Fire stations	90%+
Police stations	80%+
Developed recreational areas	95%+
Civic buildings	90%+
Buildings designated as shelters	85%+
Residential	
Single family	95%+
Mobile homes (Trailers)	95%+
Multi-family 1-3 story	
Multi-family - over 3 story	

Commercial

Office

highrise

other

Retail outlets

Motels and hotels

Industrial

Large manufacturing

Light industrial

Wholesale and warehouse

Storage tanks

2. Damage to Transportation Routes

Streets

Obstructed

trees/poles

structural debris

Road washout

Disrupted road surface

Collapsed bridges

Collapsed elevated roadways and subways

Disrupted railroad lines

Airports

Structural damage

Damage to runways

3. Damage to Utilities

Broken water mains

Contaminated resevoirs or wells**

Damage to pumping stations

Broken sewer lines

Damaged pumps

Damage to treatment plant

Power plant damage (atomic, regular)

Transformer stations

Downed power/phone lines

4. Areas of Inundation

5. Occurrence of ponded water areas -- Which might constitute a health hazard

Oil pollution

Chemical contamination

Animal carcusses

6. <u>Accumulated rubble and brush</u>

7. <u>Fire damage</u>

8. <u>Safe or shelter areas</u>

*These probability figures are based on good to excellent photography scaled at 1:7,000 or larger (1:6,000, 1:5,000 etc.) excluding contemporary architecture which might change primary identification characteristics, (e.g., church steeples absent from churches). These figures are based on experience and agreed on by several photo interpreters.

**Visual aspects of the water such as the presence of debris and soil may indicate pollution. Chemical contamination cannot be discerned by aerial photography.

What is needed to put this system into operation? Where can it be obtained?

The elements required to make this system work include an aircraft (fixed wing or a helicopter), camera(s), cameramen, film processing personnel and equipment, a photo interpreter, and photo interpretation equipment. Selected technical information about types of film and cameras appears in Appendix A. The sophistication of this system may vary from a military airplane with several mounted camera systems using a variety of film types to an observer in a helicopter or small plane using a handheld camera or simply recording information on a map or in a log.

A means of acquiring remote sensing data must be arranged for in advance of a natural disaster. The most technically advanced source of remote sensing capability is a reconnaissance wing of the military or a commercial firm that specializes in aerial photography. The photo interpreter's skills are available through both sources. Since most photo interpreters are trained in the military, they are trained to observe military environments. There is little difference, however, between civilian and military environments in terms of signatures to identify on photographs.

It may be possible in some cities to arrange for the military to overfly and photograph the disaster area. For example in Texas aerial reconnaissance may be requested from the Air Force by the State Emergency Operating Center (Civil Defense) following a disaster. These arrangements are informal but may be formalized in some states. If this source is not available, contracts may be made with local commercial aerial photography companies. If this option is used, a minimum six months planning period is recommended.

The costs and time involved in utilizing remote sensing in a disaster relief situation will vary according to the number of flights, the sophistication of the equipment, the type of film (color or black and white), the extent of the area photographed, and the detail of the information needed by the disaster manager. For example, to film a disaster using military planes and equipment takes approximately two hours to get airborne, plus flying time to and from the disaster site, with about 5 or 10 minutes to film the disaster. Black and white film can be processed at the rate of about 15 feet per minute. The time required to perform photo interpretation varies with the size of the area, the number of photo interpreters, the complexity of the area (e.g., density of structures), and the facilities available (e.g., light tables, etc.). A cursory analysis of a city the size of Austin, Texas (1000 square miles/250,000 population) would take one photo interpreter about 1 1/2 hours (150' of film).

An observer in a helicopter can facilitate the photo interpretation process by identifying quickly those areas where the heaviest damage has occurred. Crew members also can aid the photo interpreter by defining their actual flight route, identifying where they started to film (frame number), and specifying where the heaviest damage begins on the film.

How does remote sensing fit into the disaster relief process? How is this data transmitted to disaster managers?

Remote sensing can provide much of the information that disaster managers use to make decisions about relief needs. Specific decisions and the information "bits" required to resolve them were elaborated in Chapter 3. Many of the information "bits" needed by persons in agencies responsible for relief and recovery overlap, and a method for centralizing data collection is very desirable.

For remote sensing data to have an impact on disaster management a communication network must exist so that disaster managers can receive this information. As emphasized in Chapter 2, it is a prerequisite that everyone involved--disaster managers and remote sensing personnel--have the same information base (for example maps) in order to establish common reference points for communication. Maps of the affected area need to be immediately available to all department heads and relief workers who are assessing local conditions and relaying such information to a central point. Relief workers dispatched for picking up the injured or alleviating threatening conditions must also be supplied with accurate maps which are uniform in terms of scale and have common map coordinates. Such maps are necessary for locating areas of disaster conditions and important sites within the affected community such as pumping stations or hospitals.

As discussed in Chapter 2, it would be useful to have available certain information about the predisaster area. This information may be obtained from predisaster photographs or from maps. Predisaster photographs also enable the photo interpreter to identify signatures on a photograph more rapidly by clarifying questionable structures in areas where heavy damage has occurred.

They also can be used if maps are unavailable to divide a community into areas on a grid for immediate postdisaster survey. With photographs it is possible to impose a grid which could be used as a map.

An accurate overall assessment of population and area size affected by the disaster should first be made. Small scale (1:18,000) photography may be preferred for identifying the extent of the damage since this scale gives an overview of an area. The photo interpreter can identify the affected grid squares and total the population and acres (or square miles, etc.). An estimate of areas of potentially most severe, medium severe and least severe injury levels can then be made based on degree and patterns of damage. The numbers of the grid squares needing relief can be relayed to all map-holders for accurate locational identification.

Nature and severity of the disaster, hour and day, warning and preventive action, are also necessary inputs to the accurate interpretation of photographs and to the decision-making process. This information is necessary in order to determine if medical care is needed and, if it is, to estimate the extent and possibly the nature of injuries and deaths. For example, if the disaster occurred at night, whether or not the business districts of an area were damaged would not be as important a consideration as if the disaster had occurred during working hours.

After the number and types of injuries have been estimated, an evaluation of the damage to medical facilities must be made and their capacity to service the injured must be assessed. If regular medical facilities are not intact or are inadequate, supplemental facilities must be found. One alternative is first aid stations and field hospitals. Both an assessment of damage to medical facilities and locations of alternate treatment centers may be made by remote sensing.

Maps showing utility grids, water main/sewerage systems, pipeline, topography, and physical structures will invariably prove useful in assessing damage to the water and sewer system. Prior information about the locations of water wells and pumping stations, storage tanks, hydrants, sewer treatment plants, and sewer pumps will facilitate the photo interpretation process. If this data has not been coded on maps or predisaster photographs, persons familiar with these systems could assist the photo interpreter in locating these structures. When they have been located on the photographs, degree of damage can be determined. Once the area in which the water system is not functioning has been identified, an estimate of the population in need of potable water or sanitary facilities can be made and a method of supplying these needs can be determined. Estimating the population in need and identifying routes for bringing water or supplemental facilities into the disaster area lend themselves to remote sensing.

Based on pattern and amount of damage, the photo interpreter can determine whether or not shelters are needed and the approximate number and location of those in need. Damaged and inaccessible shelters also can be identified. This will ensure a more efficient selection of the location and number of shelters to be opened and the number of personnel required to staff them. Detailed analysis of degree of damage may reveal that a certain percentage of the population will require long-term temporary housing (such as mobile homes), and selection of sites may be made through remote sensing.

Assessing the need for and the availability of food is another important function in the disaster relief process. It is not possible through remote sensing to assess directly whether or not food has been contaminated. It is possible, however, with predisaster information to determine the extent of structural damage to food handling establishments and the nature of this

damage (inundation, collapse) thereby indicating which warehouses and establishments should be ground checked for contaminated food. Transportation routes for bringing in food, if necessary, can be identified.

As mentioned previously, performance of all functions depends to some degree on accessible and adequate transportation routes. Remote sensing is an extremely efficient method for identifying open routes in the postdisaster environment.

What are some of the limitations of remote sensing?

Remote sensing is one of the tools of a disaster manager, but it may not be applicable in all disaster situations. Size of the disaster is an important determinant in whether or not to use remote sensing. Field surveys may be the most timely source of information in small tornadoes and localized flooding. However, for hurricanes, major floods, and earthquakes remote sensing may provide more timely and accurate information. Communication networks, weather conditions, predisaster planning, and equipment available (aircraft, cameras, film, processing and interpreting facilities, and special personnel) are variables in the remote sensing data gathering and information provision system which may limit its availability and use. For example, the clarity of photographs will depend on the type of film, the altitude of the plane, photographic equipment, and weather conditions at the time of flight. The operation of this system needs to be considered in relation to the above named variables.

Conclusion

Remote sensing technology is presently available and can be used to provide information which will specify relief needs and expedite the delivery

of relief. Data acquired through this method is flexible (applicable in any type of disaster), specific, and timely. Implementation of a remote sensing system following natural disasters will be most effective if this system is incorporated into existing plans through predisaster planning.

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1974 "Disaster Mismanagement: A Study of the Problem and its Causes."

APPENDIX C

List of Interviews

LIST OF INTERVIEWS

NAME	DATE MAILED	DATE INTERVIEWED
Dr. Charles Barnes Manager, Health Applications Office NASA Lyndon B. Johnson Spacecraft Center Houston, Texas 77058 483-5406	8-19-75	9-11-75
Mr. Eddie Barr EOC Director Galveston, Texas 763-1261	8-20-75	11-5-75
Mr. Marion P. Bowden Coordinator Division of Disaster Emergency Services Texas Department of Public Safety 5805 N. Lamar Blvd. Box 4087 Austin, Texas 78773	8-18-75	Frank Cox substituted
Col. William Brady 1301 FM 3002 Dickenson, Texas 77539 337-2575 x202 (EOC) 337-3561	8-20-75	11/5/75
Mr. John Caswell City of Houston Civil Defense 330 Rusk Houston, Texas 77002 222-3901	8-28-75	Deferred to Fox
Dr. Earl Cook Dean of the College of Geosciences Texas A & M University College Station, Texas 77843 845-3651	8-26-75	9-5-75
Mr. Frank Cox Deputy Coordinator Division of Disaster Emergency Services Texas Department of Public Safety 5805 N. Lamar Blvd. Box 4087 Austin, Texas 78773	8-18-75	9-22-75

NAME	DATE MAILED	DATE INTERVIEWED
Mr. Howard Crain 5400 Memorial, Suite 308 Houston, Texas 862-6841	8-20-75	9-30-75
Mr. Mike Criswell Director of Utilities Department of Public Works Galveston, Texas 763-1261 x251	8-20-75	10-6-75
Mr. Atlee M. Cunningham Water Superintendent City Water Department Corpus Christi, Texas	8-28-75	Referred us to Kay Kutchins, San Antonio
Mr. Fred Fox Director EOC 330 Rusk Houston, Texas 222-3901	2-28-75	11-3-75
Mr. Charles E. Fritz Advisory Committee on Emergency Preparedness National Academy of Sciences 2101 Constitution Ave. Washington, D.C. 20418	8-18-75	
Staff Sargeant George Bergstrom Air Force Base Texas 78743	8-18-75	9-23-75
Mr. James Havens Department of Public Works Galveston, Texas 763-1261	8-20-75	10-13-75
Mr. Warren J. Holland Emergency Medical Services Galveston, Texas 763-1261 x221	8-20-75	10-13-75
Mr. Steve Huffman Galveston, Texas	10-13-75	11-5-75

NAME	DATE MAILED	DATE INTERVIEWED
Dr. Wm. Kemmerer Health Officer Galveston City/County Health Department P. O. Box 939 La Marque, Texas 77568 938-7221	8-20-75	
Mr. Charles King Texas State Health Department 706 Brentwood Austin, Texas 78773 454-3781 x531	8-18-75	Read by Jesse Root
Ms. Kay Kutchins (Through Mr. Cunningham) Training Administrator San Antonio Water Building P. O. Box 2449 San Antonio, Texas 78298	10-1-75	11-1-75
Mr. Robert Lansford Emergency Operations Center Texas Department of Public Safety 5805 N. Lamar Blvd. Austin, Texas 78773 512-452-0331 x298	8-18-75	9-22-75
Mr. Doublas Matthews Department of Transportation Planning & Grants Coordinator Galveston, Texas 763-1261 x267	8-20-75	10-6-75
Mr. Carroll McClain Department of Public Health Galveston, Texas 763-1261 x218	8-20-75	10-6-75
Mr. Ray McKinney Manager, Health Applications Office NASA Lyndon B. Johnson Spacecraft Center Houston, Texas 77058 483-5406		9-11-75

NAME	DATE MAILED	DATE INTERVIEWED
Colonel Minish 12AF/CS Bergstrom Air Force Base Texas 78743 512-385-4100 x2826	8-18-75	9-23-75
Mr. Joe Nadon Department of Transportation Galveston, Texas	8-20-75	On leave
Mr. Bill Porter Rice University Houston, Texas	8-21-75	11-3-75
Mr. Jesse Root Texas State Department of Health 706 Brentwood Austin, Texas 78773 512-454-3781 x531	9-18-75	9-23-75
Dr. Abner Sachs Science Applications, Inc. 1651 Old Meadow Road - Suite 620 McLean, Virginia 22101 703-790-5900	8-18-75	9-5-75
Mr. Larry Skiles State EOC	8-18-75	9-22-75
Master Sargeant Swanson 12 AF/CS Bergstrom Air Force Base Texas 78743 512-385-4100	8-18-75	Transferred to England
Mr. Wm. Tidball Deputy Regional Director Dept. HUD FDAA 100 Commerce Street - Room 13C28 Dallas, Texas 75202	8-18-75	
Ms. Mattie Treadwell Field Officer Region V Defense Civil Preparedness Agency Department of Defense Box 21 Austin, Texas	8-18-75	9-22-75

NAME	DATE MAILED	DATE INTERVIEWED
Mr. Mike Warren Red Cross 2006 Smith Street Houston, Texas	8-19-75	9-21-75
Mr. Charlie Williams Sewer Division Department of Public Works Houston, Texas	8-28-75	
Major Ziegler 12AF/CS Bergstrom Air Force Base Texas 78743 512-385-4100	8-18-75	9-23-75

APPENDIX D

Third Year Budget

1975-76 Budget

NASA Grant # NGL 44-084-003

1.	Personnel		
	Research associate/project director	15,100.00	
	Research Statistical Aide (1/2 time)	3,948.00	
	Secretary (1/4 time)	1,908.00	
	Sub-total	20,956.00	
	Fringe	1,700.00	
	Overhead	9,430.00	
	Total		32,086.00
2.	Telephone Communications		200.00
3.	Consultants		500.00
4.	Equipment (books)		75.00
5.	Special Costs (postage)		100.00
6.	Supplies		100.00
7.	Other (photo reproduction)		225.00
8.	Printing		400.00
9.	Travel		2,000.00
	Total		35,686.00